

## ***Interactive comment on “Hydroxyl radical reactivity at the air-ice interface” by T. F. Kahan et al.***

### **Anonymous Referee #2**

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The paper presents many results of a very accurate work, which would help shading light on the reactivity in ice. In particular, the comparison between photochemical reactions in water, the ice bulk and the quasi-liquid layer at the ice surface is a major issue in the photochemistry of the snow layers. The subject is up to date and the results relevant. The paper can, therefore, be accepted for publication following a few changes. The reviewer's comments are reported below.

#### General and specific remarks

1) One of the key issues to explain the results obtained in the present work is that the ice bulk or the liquid pockets contained in the bulk is different than the quasi-liquid layer at the surface. Interestingly, similar results were obtained in the ice bulk and in the aqueous solution, and both systems differed significantly from the ice surface. It is

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remarkable that temperature seems not to affect the studied reactions to a significant extent. Note that the aqueous solution was studied at room temperature, ice at  $-16^{\circ}\text{C}$ , and a temperature difference of about  $40^{\circ}\text{C}$  can be expected between the two systems. Accordingly, if the reaction rates were dependent on the temperature this should appear in the experimental data. The results suggest that the reaction(s) chosen by the authors were temperature-independent. If the choice of the reaction(s) to be studied we done on purpose, this should be said because a temperature-independent reaction is the best tool to compare liquid water, bulk ice and the ice surface.

1a) From page20883, line 18 to page 20884, line 9, the authors report literature comparisons of reactions in water and ice. The present work is intended to see if the differences and the contradictions in the literature results are due to the variable reactivity of different ice compartments (typically, bulk and surface). However, differences could also be due to the reactions being temperature-dependent. In the case of the monochlorophenols (Klanova et al., 2003), a check on the original reference should be made to look for a possible dependence on temperature. Such an alternative hypothesis should be discussed in the Introduction. This is important because the variable behaviour of ice is expected to play a more important role on the reactions that do not depend on the temperature. In strongly temperature-dependent reactions, the temperature effect could be the main issue in the comparison between water and ice.

1b) At the beginning of the Discussion (section 4), the authors discuss and exclude the possibility that different diffusion coefficients between ice surface and water could explain the different results in the two environments. The hypothesis would imply a temperature-dependence of the reaction, and examples of similar but different temperature-independent reactions are reported. The formation of OH in the studied systems is very likely to be temperature-independent, because for instance Figure 3 reports similar formation of OH in water and bulk ice. Accordingly, it is possible that the present paper provides evidence of the temperature independence of the studied reactions, that is more direct than the examples discussed by the authors and could be

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brought as an additional evidence to the discussion.

2) Section 3.1. The differences between ice cubes and ice granules could be due to different surface-areas vs. bulk volume ratios. However, it is also possible that the two systems behave in a different way toward illumination. Is the incident light intensity expected to be the same in the two cases? Can a different extent of radiation reflection, for instance, alter the results? This issue should be discussed in section 3.1.

Minor issues

Page 20886, top. "In aqueous solution" is repeated twice.

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 20881, 2009.

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